Progress in *Ecology:* Edition 1 (1972) to Edition 6 (2007?)

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The Central Question

- **On what major fronts has the science of ecology progressed during the last 35 years ?**

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The Background Question

- **What defines progress in science?**

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A Background Observation

- Ecologists have two broad objectives:
  - to promote an ecological world view
  - to understand ecological systems
- The first is an ethical and philosophical commitment, the second scientific

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Outline

- Why write a textbook
- The background of *Ecology*
- Distribution
- Abundance: Population ecology
- Abundance: Community ecology
- Human ecology
- The Bottom Line

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Why write a textbook?

- Dissatisfaction with the current texts available in the 1960s
- An strong commitment to the Eltonian approach to ecology
- Lectures set the stage for a textbook if one follows through

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The Background of *Ecology*

- My heros in the late 1950s were Charles Elton at Oxford, H.G. Andrewartha at Adelaide, and Charles Birch at Sydney
- Textbooks were in short supply

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Charles Elton in 1927

Charles Birch in 2001

The Major Question

- **What controls the distribution and abundance of organisms ?**

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Distribution - # 1

- The key question: what controls the geographical distribution of organisms?
- This question almost predates ecology - e.g. Warming (1896) on plants
- In 1963 T.T. Macan in England had laid out a hierarchical decision tree to answer this question

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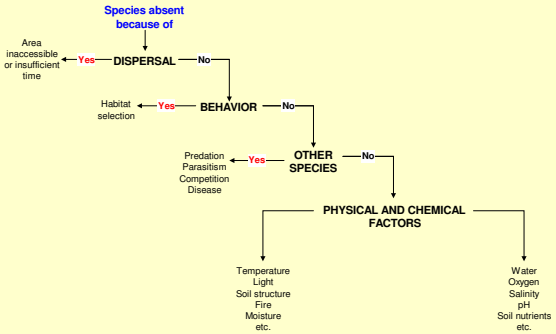
Macan's Hierarchy for Analyzing Distributions



Distribution - # 2

- Major change is the appreciation of scale-dependent answers
- Habitat selection has flourished in the last 35 years
- Climate as a limitation on geographic distributions has become a paradigm

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Distribution - # 3

- Dispersal as a limitation on distribution has emerged as the critical issue of invasive species (Elton 1958)
- Macroecology of range sizes first began in 1980s
  - abundance vs. range size

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Population Abundance

- Population arithmetic has expanded on the basics already described by 1960
- Disease was put on the population agenda about 1980
- The basics of population dynamics have not changed in 35 years

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Applied Population Problems

- Pest control and harvesting have changed little conceptually
- Conservation biology was put on the agenda about 1985 and first appeared in the 4th edition (1994)

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Behavioural Ecology

- Did not exist in 1970 as a subdivision of ecology
- Ethologists studied animal behaviour and were more akin to psychology than biology
- One of the fastest growing areas of ecology in 1980s and 1990s

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Evolutionary Ecology

- A small area of ecology in the 1960s
- Life-history theory had arisen from Cole's 1954 paper
- r- and K-selection was introduced in 1970
- Coevolution and group-selection were key topics in 1960s / early 1970s

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Community and Ecosystem Ecology - # 1

- The major issues in community ecology were already visible in 1970
  - succession
  - primary and secondary production
  - species diversity
  - stability

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Community and Ecosystem Ecology - # 2

- Major changes in orientation
- Biodiversity has taken centre stage
- Focus in 1960s on energetics – the Odum approach
- Equilibrium and non-equilibrium concepts collided in mid-1980s

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Community and Ecosystem Ecology - # 3

- In 1970 everyone believed that communities were equilibrium assemblies structured by competition
- Disturbance ecology began to gather steam in the 1980s and did not appear until the 4th edition (1994)
- Nonequilibrium viewpoint became prominent in the 1980s

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Ecosystem Ecology - # 1

- In 1970 the predominant view of ecosystems was as energy processors
- Nutrient cycling became increasingly important when climate change and greenhouse gases were recognized as threats to humans
- Ecosystem services was coined by Paul Ehrlich in 1983 and developed in the 1990s

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Human Ecology

- Human population was a strong area of concern already by the late 1960s
- Climate change did not appear as an index term in 1st edition
- Sustainable development did not appear on the horizon until the mid-1980s
  - The Bruntland Report of 1987

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New Developments since 1972

- Mathematical models were present but in their infancy
- Systems analysis was big in the 1950s but already falling from grace by the 1960s
- Landscape ecology was present only as a part of wildlife management

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New Technology since 1972

- Computers have made a large impact
- DNA technology has allowed new questions to be asked
- Remote sensing has been strongly developed but a mixed blessing
- Radio-telemetry has opened up new types of data collection

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Old Technology since 1972

- Plant sampling methods have changed little
- Mark-recapture trapping has had minor improvements
- Insect and invertebrate sampling has changed little
- Technological improvements with aquatic sampling

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Laws of Population Ecology

- Malthusian Law (geometric growth)
- Allee's Law (feedback)
- Verhulst's Law (competition)
- Hutchinson's Law (interacting species)
- Liebig's Law (limiting factors)

Berryman (2003), *Oikos* 103: 695-701.

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Laws of Community Ecology

- We do not seem to have a similar list of laws in community and ecosystem ecology

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Bandwagons of Ecology

- 1950s - Density-dependence
- 1960s - Energy flow, Stability-Diversity
- 1970s - Competition
- 1980s - Mathematical modeling
- 1990s - Disturbance, non-equilibrium
- 2000s - Biodiversity, complex systems

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The Eternal Challenge

- Ecologists wish to develop a robust, general theory of ecological systems
- All the research to date points in the opposite direction –
  - results are local and specific
  - generality difficult to achieve

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The Bottom Line - # 1

- The same problems face ecologists in 2005 as they did in 1970
- Major progress in technical tools
- Much progress in analytical statistical and mathematical methods
- Increasing number of ecologists

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The Bottom Line - # 2

- Ecology does not differ from physics and chemistry in conceptual progress
- Confusion in discussions of progress between science and technology
- Key ecological issues now are practical
  - conservation of biodiversity
  - sustainability

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The Bottom Line - # 3

- Ecology differs from other sciences in being in opposition to the dominant economic paradigm
- Politicians and too many of the public do not wish to hear about problems
- Solutions to major ecological issues are largely 'no brainers'
  - land clearing, overgrazing, CO_2

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Key Ecological Issues for this Century

- Can modern agriculture become sustainable?
- How can biodiversity be best conserved?
- How will changing climate affect ecosystem dynamics?

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What Can Ecologists Do?

- Keep asking interesting, critical scientific questions
- Promote systems-based research with research teams
- Educate the public about ecological truths, which rarely coincide with economic or political truths

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Thanks for listening!